The High-Resolution Fibre-Fed Velocity Spectrograph: VROOMM

Adventurous internship at NÜVÜ Camēras

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Introduction

The rapidly evolving photonic technologies such as optical fibres have enabled a wide range of science. One of the main applications of optical fibres is the effective transmission of light from the focal plane of a telescope to the spectrographs of the system.

The VROOMM project consists of the optical design and implementation of a high-resolution fibre-fed spectrograph at the Mont-Mégantic Observatory. This instrument is designed for precise radial measurements of nearby candidate stars that host one or more orbiting exoplanets.

Scientific Goals

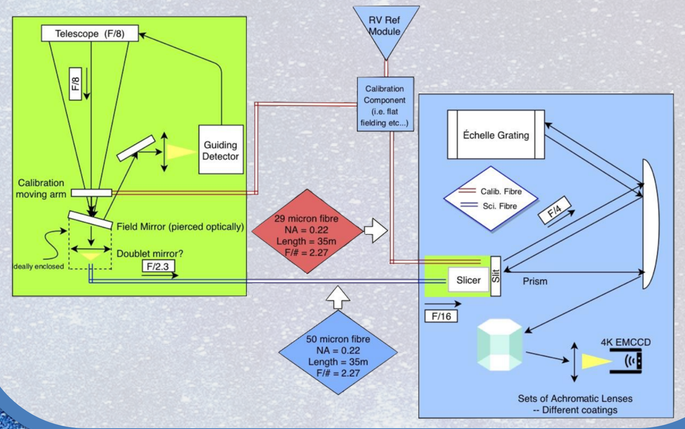
- Detection of Neptune-like exoplanets
- Characterization of stars
- Determination of the chemical abundance of stars and star-forming regions in galaxies

VROOMM

Vitesse Radiale Optique à l'Observatoire du Mont-Mégantic

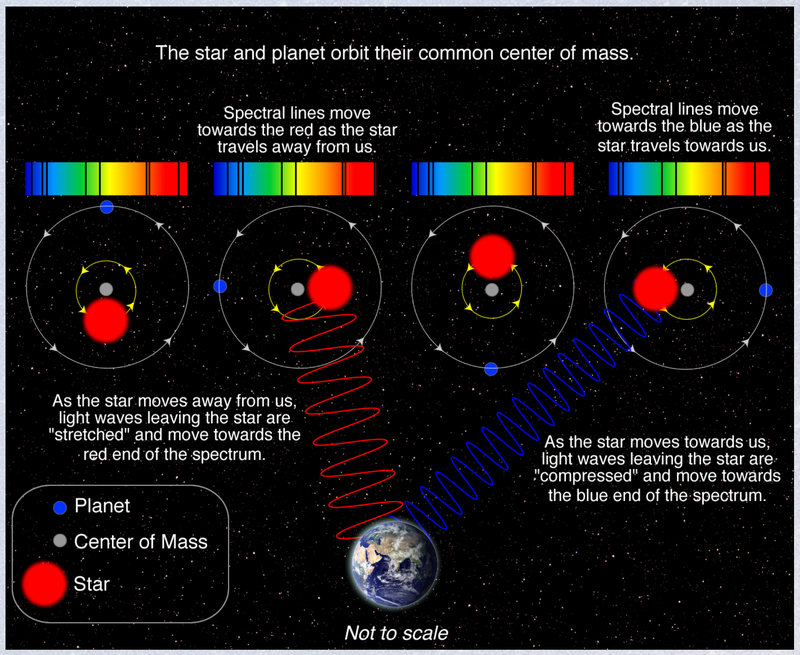
- VROOMM will be installed at the Mont-Mégantic observatory.
- The observatory houses a 1.6 m telescope that is equipped with a range of modern instruments performing imaging, spectroscopy, and polarimetry.
- This site has an exceptionally low radiation interference.

VROOMM is a fibre-fed thermally-stabilized spectrograph with a spectral resolution of over 60000 that covers the wavelength range 360-910 nm.



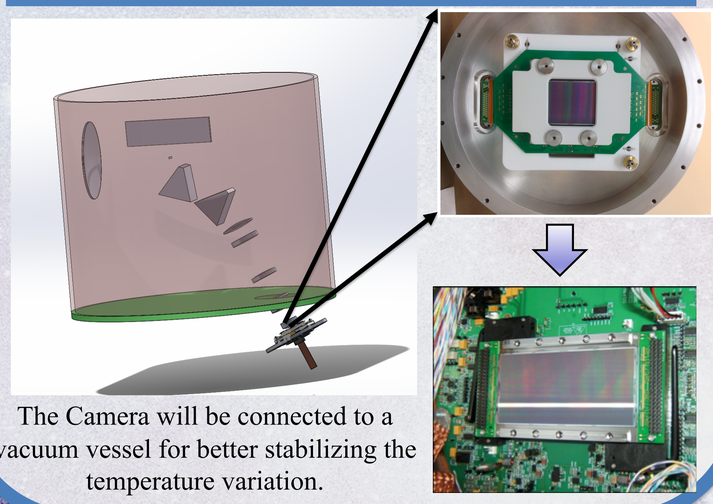
Radial Velocity (RV) Method

The RV method is an indirect method for detecting exoplanets via measuring the small reflex motion of a star caused by an exoplanet companion.



Electron-Multiplying Charge-Coupled Device (EMCCD)

- The EMCCD is an image sensor that is capable of detecting single photon events without an image intensifier via the electron multiplying structure of the chip.
- In an EMCCD, the noise is superimposed on many thousands of electrons rather than a single electron that causes an almost zero read-out noise in the final product.



The Camera will be connected to a vacuum vessel for better stabilizing the temperature variation.

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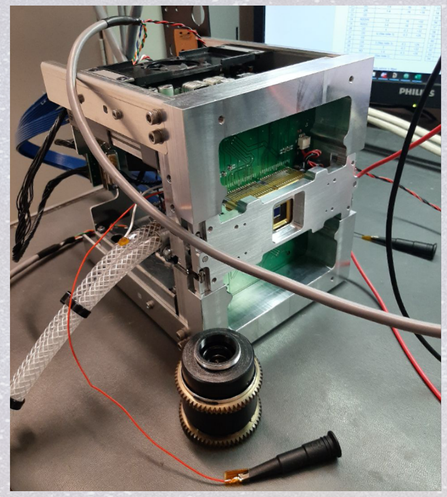
During my internship I worked on different tasks:

- I worked on multiple software, from the data reduction pipeline to the generic software that let a user grab, collect and analyze CCD images
- The hardware were inspected with helps of NUVU engineers. The capacitors were modified to make sure we have proper EM gain.
- Then the focus changed to optimization of the configuration files for 220 CCD at different frequencies (i.e. 15 MHz, 21.4 MHz and 30 MHz)



The left picture is the development jig for the CCD, not the actual camera prototype.

This development tool is used for better optimization of the hardware inside of the instrument.

Future Directions

- The optical design of the instrument will be finalized.
- The optical instruments will be tested and examined in the optics lab
- After completion of the implementation process, this instrument will be tested, and the radial velocity of several stars will be analyzed as part of the project.

Image credits:

- *Background: by Andy Holmes, https://unsplash.com/*
- *Vacuum vessel image: Philippe Vallée*
- *RV method image: Las Cumbres Observatory*